

**Before the
Federal Communications Commission
Washington, D.C. 20054**

2002 Biennial Review)	
of Telecommunications Regulations)	WT Docket No. 02-310
Within the Purview of the Wireless)	
Telecommunications Bureau)	

Comments of Powerwave, Inc

Powerwave, Inc., by its attorneys, hereby files these comments in the above-captioned proceeding. Powerwave is a leading independent supplier of high performance radio frequency ("RF") power amplifiers. Powerwave designs, manufactures and markets both single-carrier and multi-carrier ultra-linear RF power amplifiers. Powerwave's high performance products are key components in wireless communications networks, including Cellular, Personal Communications Services ("PCS") and next generation or "3G" networks. Powerwave products are subject to stringent technical standards and must undergo certification prior to marketing; accordingly, Powerwave is deeply interested in and directly affected by the Commission's regulations in these services.

Section 24.232(a) of the Commission's rules states in pertinent part:

Base stations are limited to 1640 watts peak equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT.....In no case may the peak output power of a base station transmitter exceed 100 watts.

In the past, these power limitations did not impose a significant burden because PCS systems required a limited number of RF carriers to serve many fewer subscribers than exist today. The distinctions between "transmitter," "carrier," and "channel," however imprecise, did not yet matter. As subscriber growth has skyrocketed, however, the number of carriers required to provide the needed additional voice channels must also increase. To provide the same level of service over more carriers at the same distance, it

is necessary to increase power. In addition, PCS systems have increasingly encountered local resistance to base station construction and have often had to co-locate their base stations at the same sites used for Cellular Radio. The result is a PCS physical plant spaced on a cellular design, requiring proportionally greater power at higher frequencies to cover the same subscriber base.

Gradually, the industry has encountered the limitations of Section 24.232(a) and now confronts squarely the issue of what the rules were intended to mean and what they should mean today. Inarguably, a literal application of the power limitations as written makes it impossible to provide the power needed to service PCS's phenomenal growth. Single carrier power amplifiers (SCPAs) are stuck at the 100 watt per transmitter level, and multicarrier power amplifiers (MCPAs) are unfairly disadvantaged because, since they amplify already combined carriers, they technically appear as single transmitters and are therefore limited to the same 100 watts of output power.

The EIRP restriction of Section 24.232(a) is similarly restrictive, as written. Although the rule limits the EIRP of a base station to 1640 watts, industry has long presumed, based on an interpretation of the rules in 1994, that the EIRP limit actually applies to each base station carrier. PCS base stations have been designed accordingly. It is, of course, impossible to limit the radiated power of all the many carriers of a base station collectively, to 1640 watts EIRP. Powerwave requests that the Commission finally clarify the matter by amending Section 24.232(a).

The transmitter power issue was brought to the Commission's attention earlier this year, because a literal reading of Section 24.232(a) made it difficult to obtain certification for a 125 watt MCPA. On April 4, 2002, the staff of the Wireless Bureau granted a waiver of Section 24.232(a) to permit Powerwave to obtain certification of a 125 watt Multicarrier Power Amplifier (MCPA). The staff held that application of the 100 watt transmitter power limit to MCPAs did not serve the underlying purpose of the rule which was to limit transmitter output power on a "per channel" basis and, moreover, that an additional 25 watts represented only a *de minimis* change from what the rule specifies. The staff

then invited Powerwave to seek an amendment of Section 24.232(a) to allow the authorization and use of higher power amplifiers. Powerwave, therefore, is taking this opportunity to bring this matter before the Commission and to request that the Commission review and revise the outmoded “belt and suspender” regulation of Section 24.232(a) by deleting the transmitter output power requirement entirely and confirm earlier interpretations that the EIRP limitation be applied on a per carrier basis.

Background

In the *Second Report and Order* in GEN Docket No. 90-314 (October, 1993), the Commission established the initial rules for the operation of broadband PCS.¹ (The *First Report and Order* dealt with narrowband PCS). There, the Commission adopted a maximum power level of 100 watts EIRP and a maximum antenna height limit of 300 meters for PCS base stations (higher powers were permitted with corresponding decreases in antenna height). These limits applied to base stations and there was no transmitter output power restriction.² For all practical purposes, the term “base station” was not defined.

Subsequently, in its *Reconsideration of the Second Report and Order* in June 1994, the Commission, pursuant to industry demand, raised the base station EIRP limit to 1640 watts.³ Because of its concern that a higher power base station might transmit beyond a mobile unit’s ability to respond, the Commission also adopted a power output limit for base station transmitters of 100 watts. The Commission stated that it was attempting to promote the use of directional antennas to serve large sectorized coverage areas in which mobile units would still be able to respond to the base station. The language in the *Reconsideration Order* appeared to apply the 100 watt power maximum to the transmitter output power of a base station and did not discuss the implication of such a restriction on base stations with multiple transmitters. The rule that was adopted, however, states that

¹ 8 FCC Rcd 7700

² To some extent the Commission was attempting to provide PCS operators with the power they needed while at the same time attempting to make it easier to coordinate and share spectrum with incumbent fixed microwave users. This is no longer an issue.

³ 9 FCC Rcd 4957

the power output restriction applies to the output power of a base station transmitter, suggesting the Commission understood that a base station would have multiple transmitters, each of which would be limited to 100 watts maximum power.

It is important to note that, at the time of the *Reconsideration Order*, MCPAs had not yet been developed. Base station amplifiers operated on a per channel basis so that “transmitters” and “channels” were effectively synonymous. In paragraph 173 of the *Reconsideration Order*, the Commission made this clear when it talked about using high gain antennas to ensure that the link between the base and mobile stations would be “in balance.” It was the link that was important to the Commission – and by links the Commission meant the individual traffic channels as opposed to the combined output power of all the transmitters employed in base stations.

It was not long before the Commission had to address this issue again. In the *Third Memorandum Opinion and Order on Reconsideration* in Docket 90-314, Spatial Communications and ArrayComm had requested the Commission to redefine the power output rule in terms of units of power per bandwidth (spectral density). These parties noted the possibly disparate treatment of narrowband and broadband PCS by pointing out that power for narrowband PCS was expressed on a per channel basis whereas for broadband it was expressed on a per transmitter basis.

Although the Commission declined to re-define its transmitter power limits, it offered a “clarification” of its rule as follows:

As regards power levels per transmitter, antenna or antenna element, it was always our intent that the 100 watts per channel and 1640 watts EIRP requirements apply to these individual components and not to the sum of all components at the entire base station provided the maximum EIRP radiated by the base station in any given direction on any given channel does not exceed 1640 watts. [emphasis supplied]⁴

⁴ 9 FCC Rcd 6908, 6918

Here the Commission seems to be saying that its output power and EIRP limits were intended to apply on a per channel basis. Indeed, the only confusing element in this “clarification” is that the rule itself was not changed, accordingly.

Today, it is appropriate to speak in terms of RF carriers, and use the term channel to designate a voice or traffic channel encoded within a carrier. Power is measured over the carrier’s bandwidth and, depending on the form of modulation used (e.g. TDMA, CDMA, GSM, etc.), bandwidths can vary greatly.⁵ Thus, the Commission’s use of “channel” in its clarification statement, above, is anachronistic because PCS operators no longer equate channels with carriers. It is reasonable, therefore, to interpret the Commission’s use of the word “channel” in the 1994 clarification as “carrier.”

The Disparate Treatment of SPCAs and MCPAs

Powerwave believes that a proper interpretation of Section 24.232(a) must take into account the base station technology that existed in 1994 when the Commission last spoke on the matter. Back then, when base stations were configured with a mix of single channel (carrier) radios and amplifiers, power per transmitter meant the same thing as power per channel (carrier). The Commission’s express statement in its clarification that the EIRP limits are a “per channel” (carrier) requirement not only bears this out but compels an interpretation that the 100 watt power limitation per transmitter is also a per carrier limitation since the two go hand in hand and the objective was to maintain a balance in the traffic channel link between base stations and mobile units.

The uncertainty created by the language of the rule did not become significant until the introduction of multicarrier power amplifiers into the PCS market around 1999.⁶

⁵ For instance, the bandwidth of a TDMA carrier is 30 kHz; a GSM carrier, 200 kHz and a CDMA carrier, 1250 kHz.

⁶ The commercial reasons why the base station industry is moving toward an MCPA design are manifold: improvements in intermodulation distortion cancellation over high power combining designs; improvements in frequency channel spacing which increase network calling capacity; improvements in transferring final transmit power to the antenna; redundancy; the flexibility for mixed-mode capability permitting some operators to transfer from one transmission technology to another (i.e. TDMA to GSM) without replacing the power amplifiers; space and design efficiencies; and operating efficiencies that

Section 24.232(a) restricts “transmitter” output power to 100 watts. The term transmitter is defined nowhere in the Part 24 rules. Logically, however, transmitter means a physically separate radio, plus dedicated amplifier, connected to an antenna. Thus an arrangement of ten separate radios, each with its dedicated amplifier, the signals of which are then combined and fed to a common antenna would reasonably be considered ten separate transmitters, although enclosed in the same box. If the output power of each transmitter is no more than 100 watts, even though the antenna output would be the sum of all the transmitters (after losses), the box would comply with Section 24.232.

An MCPA system, however, has a different architecture. When an MCPA is used, the low power output of the ten radios is combined first and then sent to the MCPA which amplifies all signals at once and then feeds them to an antenna. In this configuration, because of the common amplification, physically speaking, there is only one “transmitter” and the 100 watt limitation applies to its output power.

On its face, the disparate treatment of these two configurations can make no sense. In terms of output power, it should not matter whether carriers are combined before or after amplification. In neither case is the level of service to subscribers affected nor do the two configurations present different interference concerns. Thus, there would seem to be no regulatory basis for treating these configurations differently. Indeed, based on a fair reading of the history of Section 24.232(a), it seems clear that the Commission never intended its rules to have such an arbitrary, technology-forcing impact on PCS base station design. Quite the opposite, at various times the Commission has used the terms “transmitter” and “channel” interchangeably and even sought to explain that its rules were not intended to artificially favor (or limit) one particular base station design over another.⁷

eliminate the large losses incurred during high power signal combining. Further, it is important to note that as the industry moves to implement GSM and similar internationally-harmonized protocols, greater power is required on a per channel basis to provide the same coverage and reliability as the CDMA systems against which they compete.

⁷Id at note 4

It is Powerwave's contention then, that, if the Commission remains wedded to the outmoded EIRP and output power restriction, MCPAs should be treated as if they are combinations of single channel amplifiers in a common enclosure, each amplifying individual radio channels limited to 100 watts. Under such logic, the total output power of an MCPA would be irrelevant. All that should matter under the rules is that the output power of each carrier never exceeds 100 watts.⁸ A literal reading of Section 24.232(a), however, stands this logic on its head. Powerwave, for instance, is developing a MCPA that will provide 8 carriers of 25 watts each for a total of 200 watts. Individually amplified, each of these carriers would comply with Section 24.232(a) as it now exists. Combined in an MCPA, however, the rule limits the power by half.

Powerwave believes that, at the very least, the Commission should amend Section 24.232 to provide that the output power of each carrier not exceed 100 watts. But, in fact, even 100 watts per carrier is not reasonable in today's environment. In the real world, PCS operators who do not choose the more expensive MCPAs and prefer single carrier amplifiers now realize that, given the need for more power (depending on the modulation type of the system), and the significant losses suffered within the transmission system before the RF signal reaches the antenna, transmitter power of more than 100 watts is essential. The Commission could permit measurement of transmitter power at the antenna – to account for these losses – but, because losses will vary from system to system, it would be difficult to specify a power rating for the amplifier. Sensibly, therefore, the Commission, in one stroke, can solve these problems by simply eliminating the output power restriction entirely and relying solely on a limit for the radiated power (EIRP) of each transmitted carrier.⁹

⁸ In fact, this is precisely the way an MCPA operates. At the time of deployment, an MCPA must be "provisioned" (programmed) by the PCS licensee. This means the licensee must determine how many channels are to be amplified and the level of amplification assigned to each. Every licensee is bound by Section 24.232 to ensure that no channel will be provisioned for more than 100 watts of power. Once a channel is provisioned it can only be amplified as designated; thus, in Figure 2 an MCPA provisioned for 28 channels at 4.47 watts each could never output more than 4.47 watts on any channel regardless of how many other channels are in use. In this fashion, an MCPA operates just like a combination of individual amplifiers where each is unaffected by the operation of the others.

⁹ Under this regulatory scheme, an amplifier would be certificated by the Commission based only on its ability to comply with the Commission's spurious emissions requirements, not on its power output.

Such a policy is not without precedent.¹⁰ It will be recalled that when the rules were first adopted in 1993, there was no output power restriction at all – only a restriction on EIRP. The reason given for the addition of an output power restriction was that it was necessary to retain some balance between base station transmitter power and the ability of a mobile unit to respond to the base station. The Commission worried that too powerful a base station would outrun its mobile units. Surely, this somewhat paternalistic philosophy would not be adopted today in an environment of highly competitive mobile radio services. No PCS licensee would intentionally design a system that rendered use of mobile units less effective. It is in every PCS operator's self-interest to optimally balance the link between its base station and mobile units. Any other architecture would result in subscriber defections to competing mobile systems. Cellular and PCS systems have been the competitive success the Commission hoped for many years ago. It is no longer necessary for the government to worry that, but for a Commission rule, a PCS operator will transmit beyond a mobile unit's capacity to respond. The "transmitter," or more properly, "carrier" output restriction has long outlived its usefulness, and Powerwave urges the Commission to remove it entirely in order to provide the PCS industry and its equipment manufacturers the flexibility for future development.

Clarification of the EIRP Requirement

Section 24.232(a) states that "base stations" are limited to an EIRP of 1640 watts with an antenna height up to 300 meters HAAT. This is the rule that was adopted in 1994.¹¹ This part of the rule too, was affected by the "clarification" later that year. The Commission said that the 100 watts per channel and 1640 watts EIRP requirements apply individually to the "transmitter, antenna or antenna element" and "not to the sum of all components at the entire base station, "provided that the maximum EIRP radiated by the base station in any given direction on any given channel does not exceed 1640 watts."¹² As noted above, Section 24.232(a) has not been changed to reflect the clarification.

¹⁰ Other similar technologies have simply an EIRP limit. The Narrowband PCS and Cellular Radio Services, for instance have only an ERP limit per channel.

¹¹ Id at note 4

¹² Id at note 5

By the time of the clarification, the Commission recognized that base stations would become sectorized – hence the use of the term, “in any given direction,” and moreover that the radiated power of concern was for each “channel” – properly, as noted above, each carrier. Given this interpretation, the industry has moved forward and now it is frequent to find individual carriers transmitted at radiated powers approaching the 1640 watt limitation. For instance, a typical PCS antenna has 17 dBi of gain. Given an average cable loss of 2 dB, the net gain is 15 dBi. When connected to a single carrier³⁰ watt GSM RF amplifier, this yields an EIRP of 948.7 watts. Obviously, multiple carriers feeding the same antenna will result in a much higher EIRP, exceeding the 1640 watt limit. This, however, is standard industry practice which exists because of the 1994 clarification that EIRP was to be determined on a “per channel” basis. The rule should finally be amended to reflect both that clarification and the industry practice that has arisen from it.

That Section 24.232(a) has not been amended to comport with both its interpretation by the Commission and to reflect common industry practice can probably be explained by the fact that there was no need to do so. Operators and base station manufacturers thought they understood what it meant and proceeded accordingly. No one complained. The Commission had no reason to address it. And so it remained, a product of administrative and industry inertia, causing no great harm. But, as times have changed, with the introduction of MCPAs, the need to provide additional carrier architectures to augment the number of voice channels, and the adoption of different modulation schemes requiring more power, a literal reading of the rule now can only serve to artificially limit the growth and success of the PCS industry.

Conclusion

From 1993, when the Commission first authorized broadband PCS systems until the present, subscriber growth has increased, and is continuing to increase, dramatically. The Commission's measurement of this growth combines mobile telephony services (Cellular, PCS and SMR) and indicates a staggering nationwide penetration level of 45%.¹³ The Commission reports that in the twelve months ending December 2001, mobile telephony subscribership increased by 27 million. Just as significant is the Commission report that the average minutes-of-use per subscriber per month increased dramatically – up 51 percent between July and December 2001, according to CTIA. In other words, many more people are making more calls and occupying voice channels for longer periods of time. It is incumbent upon the Commission then, to remove regulatory roadblocks, however unintended they may be, that will prevent PCS operators from responding to the huge and continuing demand for service. A review of PCS rules that may inadvertently discourage this growth is overdue. Certainly, it makes sense to begin this review by focusing on the rule governing PCS power.

As we have noted earlier, the equation is simple. Increased demand for service requires the provision of more voice channels, which in turn requires the activation of more RF carriers which requires the use of more power. It is important to emphasize that more power is not needed to transmit further, but only to support increased capacity in the same area. Unfortunately, if read literally, the power restrictions of Section 24.232, to some extent a vestigial remnant of earlier times, will thwart the needed PCS response to increased demand.

Powerwave respectfully requests that in order to provide PCS systems the flexibility to improve their systems and serve more subscribers, the Commission amend Section 24.232 by eliminating the transmitter output power restriction, and revising the EIRP limitation to apply on a per carrier basis. The transmitter output power restriction, apart

¹³ See 7th Annual Report and Analysis of Competitive Market Conditions with Respect to Commercial Mobile Services, FCC 02-179, released July 3, 2002.

from its use of the confusing and undefined term, "transmitter," is the product of an earlier Commission concern that PCS base station transmissions, if too powerful, would reach further than the ability of a mobile unit to respond. In today's highly competitive environment, this concern is no longer justified. The EIRP restriction should simply be amended to conform to the Commission's earlier explanation that it applies on a per carrier basis, which, as a result has become industry practice.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Robert J. Ungar", with a long horizontal flourish extending to the right.

Terry G. Mahn
Robert J. Ungar
Fish & Richardson P.C.
1425 K Street, N.W.
Suite 1100
Washington, D.C. 20005
(202) 783-5070

Counsel to Powerwave, Inc.

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